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The Effect of Sulfentrazone and Glyphosate Herbicides to Control *Eleusine Indica* L. a Resistant weed to Herbicide

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Abstract

Weed *Eleusine indica* L. was reported to have been difficult to control using glyphosate in Oil palm plantation during the time. Sulfentrazone was used as an alternative herbicide for the management of resistant weeds. The aim of this study was to determine the effects of two active ingredients Glyphosate and Sulfentrazone on weed *Eleusine indica* L. resistant to herbicide. The study was conducted using Completely Randomly Designed (CRD) with 14 treatments and 3 replications. 14 treatments consisted of single herbicide Glyphosate, which was applied at field rate 2 l ha^{-1}, Sulfentrazone was sprayed at the numerous dose of 500, 750, 1000, and 1250 $mlha^{-1}$, and the mixture of Glyphosate and sulfentrazone at the dose of 500 $mlha^{-1}$ + 2 l ha^{-1} and 750 ml ha^{-1} + 2 l ha^{-1}, respectively. The research was conducted at the Greenhouse of the Faculty of Agriculture, Andalas University, Padang, from August to December, 2021. The results showed that there were significantly effect when used in combination of herbicides Glyphosate and Sulfentrazone, showed 100% of mortality weed 3 week after application. For a single active ingredient, Glyphosate controlled eficiently weed at the 4-leaf stage, Sulfentrazone had same impact on managing weed on the 4 and 6-leaf stage, both caused 100% weed dead. However, weed *Eleusine indica* L. was treated with Glyphosate still survived on 6 and 8 leaves weeds. Similar to Glyphosate, Sulfentrazone could not completely control resistant weeds at the 8-leaf stage.

Keywords: *Eleusine indica* L., Glyphosate, Sulfentrazone, resistant weed, resistant to herbicide.

1. Introduction

Eleusine indica L. Gaertn is a widespread weed whose existence found invarious places such as plant cultivation, especially in annual crop fields like orchards or oil palm (ElaeisguineensisJacq. L.) in Indonesia. Eleusine indica L. leads to a production loss of plant cultivation in the area where it is present, disturbing the production of plants and main-nursery (Holm et al., 1977; Ma et al., 2015). Glyphosate is a widespread herbicide used in the world. An annual review article reported the amount of 9.7 million kg of the active ingredient of Glyphosate herbicide used in Indonesia (Brookes, G. 2019; Hugh J. Beckie et al., 2020). In Indonesia, Glyphosate is applied up to three times to control weeds in Oil palm plantations, both pre-emergence and between crops in the growing stage, approximately two-thirds of total Glyphosate use (Brookes, G. 2019). Sulfentrazone is applied as an active ingredient herbicide with excellent management of grass weeds, broad-leaf weeds, and nutsedge. Sulfentrazone can manage weed Eleusine indica L at the pre-emergence stage, but the mature weed is ineffective controlled (Anonymous 2003, 2008). Herbicide application is one of the most effective methods to control weeds. However, applying a single herbicide to control weeds for the long term may cause weed resistance to the herbicide. Resistant weed can happen because using the same mode of action or active ingredient repeatedly and continuously will result by selection in the growth of selected weed resistant to the herbicide. Heap I. (2020) showed that Eleusine indica L. was resistant to Glyphosate in Oil palm nurseries in Indonesia. Many weed populations intended to be resistant or tolerant to herbicides, for instance, a case at the oil palm nursery plantation of Palm Oil Plantation of Perkebunan Nusantara. Glyphosate was used to control weed Eleusine indica L. repeatedly and continuously for ± 26 years. The growth of usage of single herbicide caused Eleusine indica L. to lead on difficulty to manage, eventually increasing the dose of herbicide application (Junita Br. Nambela, 2019). This research aims to obtain the effect of Sufentrazone and Glyphosate herbicides to control Eleusine indica L. resistant weed to the herbicide.

2. Materials and Methods

The research was conducted during the period of August to December, 2021, in the Greenhouse of Faculty of Agriculture Andalas University, LimauManis, Padang, West Sumatra, Indonesia. (latitude: 0°54'41"S, longitude: 100°27'33"E, altitude: 253m). The materials used in this research were seed of weed *Eleusine indica* L. and two active ingredients of herbicide: Glyphosate (trade name Round-Up 486 SL) and Sulfentrazone (trade name Boral 480 SC). And the other supporting equipments used in the experiment were hand sprayer, measuring cylinder, tray, watering can, label, camera, notebook, pen, ruler to record the data.

The treatments were arranged in the Completely Randomized Design (CRD) with fourteen (14) treatments and three (3) replications. 14 treatments consisted of single herbicide Glyphosate, which was applied at field rate 2 l ha^{-1}, Sulfentrazone was sprayed at the numerous dose of 500, 750, 1000, and 1250 $mlha^{-1}$, and the mixture of Glyphosate and sulfentrazone at the dose of 500 $mlha^{-1}$ + 2 lha^{-1} and 750 $mlha^{-1}$ + 2 l ha^{-1}, respectively. There are 42 trays total for this research and 50 seeds of the weed *Eleusine indica* L. for each tray. Data was analyzed statistic using Excel, IBM SPSS Statistics 20 software and the means were separated using *Duncan's Multiple Range test* (DMRT)at 5% significance level.

The media for planting is using combination of topsoil, manure, and sand in a ratio (1:1:0.2), the soil is mixed together and watering one week before planting the seed of weed. The size of the tray is 33 cm x 24 cm x 4.2 cm and fill 3/4 of its size. The total number of trays required is 42.

The seed of the *Eleusine indica* L. using in this research is resistant to herbicide from the previous study conducted by Maya Safitri (2020). The weed seeds were soaked in a solution of KNO3 with a concentration of 0.2 % for 24 hours to break the dormancy of *Eleusine indica* L. seeds. After two weeks of incubation, the weed seed start to emerge. The seedlings were planted in pot until it has 1-2 leaves stage then transplanted into the tray, and the number 50 seeds per tray. Watering gently were done every afternoon every day to keep the moisture.

Observation

The number of mortality weed

The number of mortality weed is observed every day by counting the total number of dead weed on three weeks after herbicide application(Jalaludin et al. 2015).

$$\text{Percentage of mortality weed (\%)} = \frac{\sum \textit{Eleusine indica} \text{ L. dead}}{\sum \textit{Eleusine indica} \text{ L. planting}} \times 100\ \%$$

Resistant weed

The classification of resistant weed is base on the percentage of mortality of *Eleusine indica* L. Data are

collected for three weeks after the application of herbicide. The percentage range from 0 to 100 percent (0 – 100 %). There are three classifications: Susceptible (S) if the percentage mortality of *Eleusine indica* L. is more than 98 – 100 %, Developing resistance (DR) if the percentage mortality of *Eleusine indica* L. is more than 80 – 98 %, and Resistance (R) if the percentage mortality of *Eleusine indica* L. is less than 80 % (Owen and Powles, 2009; Tampubulon et al., 2018).

3. Results and Discussion

Mortality of weed after application of herbicide

Applied Glyphosate and Sulfentrazone herbicide on the resistant weed *Eleusine indica* L. to find out what herbicide can control effectively the resistant weed, using both single active ingredient and mixtures active ingredient of herbicide for the evaluation. The result on the mortality of the weed (percentage) was recorded within three weeks and then analyzed statisticly as showed on the Table 1.

Table. 1. Mortality rate of Eleusine indica L. During three weeks after herbicides application

Treatments	Week 1	Week 2	Week 3
H1	0.00e	12.67h	19.33d
H2	43.33c	100.00a	100.00a
H3	41.33c	100.00a	100.00a
H4	42.00c	100.00a	100.00a
H5	53.33b	85.33bc	100.00a
H6	68.00a	91.33b	100.00a
H7	28.00d	23.00g	82.67b
H8	40.67c	84.67cd	100.00a
H9	43.33c	86.00bc	100.00a
H10	22.00d	52.67f	82.67b
H11	22.00d	59.33e	78.67b
H12	26.00d	22.00g	70.00c
H13	41.33c	78.67d	100.00a
H14	42.00c	80.67cd	100.00a
Sig	*	*	*

*Note: values within each column with the same letters are significantly different by Duncan's test, * significant different at 5%.*

H = Herbicide

Based on Table 1., the application of single active ingredient Sulfentrazone gave the highest result on controlling resistant weed by 68% of mortality after 1 week of treated herbicide at the dose 1250 $mlha^{-1}$ (H6), followed by treatment H5 at the dose 1000 $mlha^{-1}$ at the 6-leaf stage (53%). However, using the same level of herbicide (H10, H11) on the 8-leaf stage gave the effective control weed less than 50% of mortality. The similar result also found on treatments H2 and H3 at the 4-leaf stage at the dose 500$mlha^{-1}$ and 750 $mlha^{-1}$, respectively. The symptom of the weed being treated with Sulfentrazone had the color turn to yellow, brown and died after that. Then after two weeks applied herbicide, treatments H2 and H3 gave 100% mortality of resistant weed *Eleusine indica* L., then there was not the regrowth in these treatments until 8 weeks application. This is consistent with the literature of Laurenco & Carvalho (2015) that the usage of active ingredient Sulfentrazone to manage weed can be remained persistently in soil up to 182 days after herbicide application and the weed wil be suppressed until 8 weeks application. Treatments H5 and H6

managed more than 85% of mortality weed after 2 weeks herbicide application and 100% of mortality weed after 3 weeks herbicide application. At the 6-leaf stage of weed, active ingredient Sulfentrazone gave the result controlling weed by more than 50% and about 80% of mortality weed in treatments H10 and H11. On the study of Maya safitri*et al.* (2020) had the similar result of using Sulfentrazone control uneffective resistant weed *Eleusine indica* L. at the 1000mlha^{-1} and 1250 ml ha^{-1}. Takano H.K. *et al.* (2017) reported that Sulfentrazone provided 100%, 97%, and 94,5%, respectively of controlling *Eleusine indica* L. after 20 days, 35 days, and 60 days after application of herbicides in pre-emergence however application in the post-emerge gave the effect less than 60% to control weed (Shoup and Al-Khatib, 2004).

Treatments H4 using Glyphosate to control *Eleusine indica* L. weed gave the effect 100% of mortality of weed after 2 weeks applied herbicide. This is similar to report of Ulguim*et al.*, 2013 that control *Eleusine indica* L. weed used Glyphosate is more effective in the early development stage, because these weeds are greatest sensitive to herbicide in that peroid. H7 and H12 used Glyphosate to control *Eleusine indica* L. weed on both the 6 and 8-leaf stage of weed showed highest 28% of mortality of weed after 2 weeks treated herbicide and 82% after 3 weeks treated herbicide. Koko Tampubolon et al. (2020) also stated that *Eleusine indica* L. population was resistant to Glyphosate at the dose 2 l ha^{-1} at oil palm estate in the Asahan Regency. According to Takano H.K. *et al.* (2017) that *Eleusine indica* L. was controlled ineffectively by glyphosate with 60% and 70% at the level of 960 and 1920 gha^{-1}, respectively at the 1-tiller stage after 28 days treated herbicide.

The seed of weed *Eleusine indica* L. used in this research was from the study of Maya safitri*et al.* (2020) that the weed was planted and treated with Glyphosate at the dose 2lha^{-1}, this weed still survived then waiting until the blooming stage to take the seed of these resistant weed. The sourse of seed weed used in the study of Maya safitri*et al.* (2020) was from the research of Pratiwi (2019), these *Eleusine indica* L. population was confirmed resistant to Glyphosate at dosage 5 lha^{-1}, and had the history of being treated with Glyphosate for more than 10 years from PT AKO (Pasaman Barat). This illustrates that the populace of weed has been intensely experienced with the active ingredient and the same dose of glyphosate herbicide for a long-term so dominant resistance to herbicide (Tampubolon K. and Purba E., 2018). And it also coherent with the literature of Purba E. (2009) which that the continuous and repeated application of the herbicide with the same active ingredients or the same of working method for a long time in an area may cause the problematic weed by producing the dominance of herbicide resistant/tolerant weed.

The result on Table 1. also shown that the effect of controlling weed *Eleusineindica* L by apllied mixtures 2 active ingredient Sulfentrazone and Glyphosate gave 100% weed died after 3 weeks apllication herbicide. According to Meilin and Yardha (2010) explained that the action of mixing herbicides can increase the effect of weed control to create a synergistic interaction that can stimulate biology activity.

Chart 1. Percentage of the weed *Eleusine indica* L. that Susceptible (64%), Developing resistance (14%) and Resistance (22%)

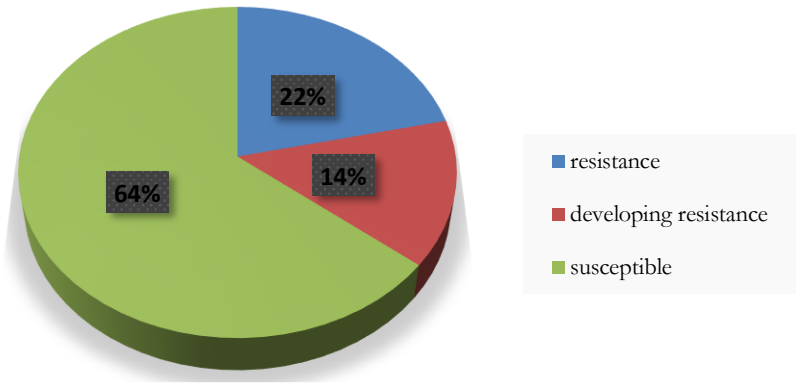

Chart 1 showed that after the application of herbicides with 14 treatments including single active ingredient and mixture active ingredient on the resistant weed*Eleusineindica* L., there were 9 treatments (64%) classified as a susceptible to herbicide, classification based on the percentage of mortality of *Eleusine indica* L. > 98-100%, 2 treatments (14%) classified as a developing resistant to herbicide was obtained if the percentage of mortality of *Eleusine indica* L. > 80-98%, there were 3 treatments (22%) classified as a susceptible to herbicide, beacuse the percentage of mortality of *Eleusine indica* L. ≤ 80%.

Table 2. The wees Eleusine indica L. Classification after three weeks of application herbicide

	Resistance	Developing resistance	Susceptible
H1	√		
H2			√
H3			√
H4			√
H5			√
H6			√
H7		√	
H8			√
H9			√
H10		√	
H11	√		
H12	√		
H13			√
H14			√

Note : Susceptible (Eleusine indica L. mortality > 98-100%); resistant developing (Eleusine indica L. mortality > 80-98%); R: resistant (Eleusine indica L.mortality ≤ 80%) (Owen and Powles 2009).

The classification of resistance to herbicide after three weeks of applied herbicide of resistance weed *Eleusine indica* L. is shown on the tabled 2. The classified of weeds susceptible to herbicide included treatments H2, H3, H4, H5, H6, H8, H9, H13, and H14, all the resistant weeds in these treatments were 100% of mortality after three weeks of treated herbicide. Single active ingredient Sulfentrazone used to control resistant weed *Eleusine indica* L. was on the 4-leaf stage of weed at the dose 500mlha^{-1} (H2) and 750 mlha^{-1} (H3); on the 6-leaf stage of weed at the dose 1000mlha^{-1} (H5) and 1250 mlha^{-1} (H6). In treatment H4 using Glyphosate on 4-leaf stage weed at the dose 2lha^{-1}. Loddo D. *et al.* (2020) reported the similar result that the susceptible *Eleusine indica* L. were totally managed (100% of moratlity weed) at 360 g aeha^{-1}. Treatments using a mixture of 2 active ingredients Sulfentrazone and Glyphosate were on the 6-leaf stage of weed at the dose 500mlha^{-1} + 2lha^{-1} (H8) and 750mlha^{-1} + 2lha^{-1} (H9), on the 8-leaf stage of weed at the dose 500mlha^{-1} + 2lha^{-1} (H13) and 750mlha^{-1} + 2lha^{-1} (H14), respectively. The mortality of resistant weed *Eleusine indica* L. was 82.67 % (Table 1), classified as developing resistance to herbicide in treatment H7 using Glyphosate at the dose of 2lha^{-1} on the 6-leaf stage of weed. This is similar to result of *Eleusine indica* L. population applied Glyphosate at the dose 540 g aeha^{-1} and 1080 g aeha^{-1} that gave 90.7% and 96.5% of mortality weed, respectively (Purba, E. &Sipayung R., 2021). In treatment H10, resistant weed *Eleusine indica* L. was also resistant to Sulfentrazone herbicide at the dosage of 1000ml/ha on the 8-leaf stage of weed (82.67% of weed mortality). Resistant weed *Eleusine indica* L. in treatments H11 and H12 were confirmed resistant to Sulfentrazone and Glyphosate herbicide, at doses 1250mlha^{-1} and 2lha^{-1}, respectively, on the 8-leaf stage of weed by 78.67% and 70% of weed mortality. In the study of Tampubolon and Purba, (2018) shown that *Eleusine indica* L. populations were resistant to glyphosate at the dose 2 lha^{-1}. In another research of Tampubolon et al. (2018) also reported that *Eleusine indica* L. populations were resistant to glyphosate at the dose 2 lha^{-1}.

The result on the Table 1 and Table 2 shows that *Eleusine indica* L. on the 6 and 8-leaf stage was not effectively controlled after three weeks of herbicide application, which corresponds with the literature that mature plants in an advanced stage will be coated with greater of wax composed in the epidermis, which acts as a partition to prevent herbicide absorption, therefore limit the active ingredient entry into the cuticle cells and phloem then carrying out their site of action (Chamel and Vitton, 1996; Malpassi, 2006; Takano H.K. et al., 2017). According to Knezevic et al.

(2017), herbicide-resistant weeds are the weed species that have The use herbicide continuously in oil palm plantations will result the selection of weed populations that have the ability to develop and keep surviving after being experienced to herbicides (Knezevic et al., 2017) hence so dominace of resistant/tolerant to herbicide, then cause the problematic on control these weed.

4. Conclusions

Application herbicide using single active ingredient Glyphosate (at dose 2 l ha^{-1} at the 4-leaf stage) and Sulfentrazone (at various dose 500 ml ha^{-1} and 750$mlha^{-1}$ at the 4-leaf stage; 1000$mlha^{-1}$ and 1250$mlha^{-1}$ at the 6-leaf stage) gave the result of 100% mortality weed. Application used mixtures herbeicide also gave the same result on control resistant weed *Eleusine indica* L. to herbicide. However, at the 6and 8-leaf stage, *Eleusine indica* L. was classified as resistance/developing resistance weed to herbicide. Therefore, alternative herbicides (different of active ingredient or working method) and mixtures herbicides that are effective on control resistant weed may be recommended to overcome the resistant-herbicide species and diversity in weed control strategies is also the most important tactic for reduction and controlling the development of weed resistance.

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